Australian Bureau of Statistics

4631.0 - Employment in Renewable Energy Activities, Australia, 2015-16

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Summary

Main Findings

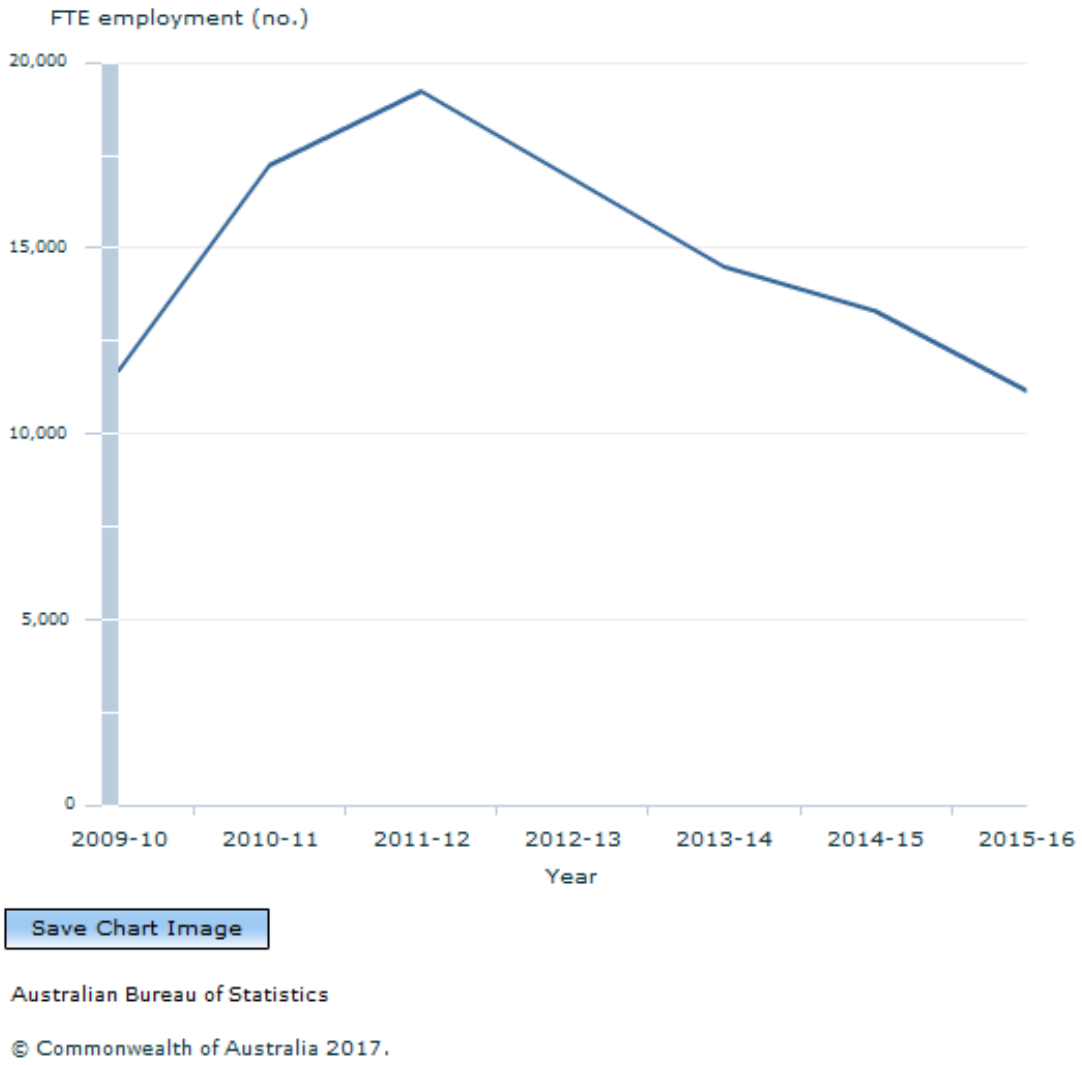
MAIN FINDINGS

This publication presents estimates of direct full-time equivalent employment in renewable energy activities in Australia, for the years 2009-10 to 2015-16. These estimates should be regarded as experimental as improvements continue to be made to the estimation methods and as new data sources continue to be identified.

OVERVIEW

Annual direct FTE employment in renewable energy activities in Australia was estimated at 11,150 in 2015-16. As Figure 1 shows, this is a decrease of 2,150 FTE (-16%) from the previous year (2014-15) and a decline of 8,070 FTE (-42%) from a peak of 19,220 in 2011-12.

Figure 1 - Annual direct FTE employment in renewable energy activities in Australia, 2009-10 to 2015-16



Source(s): Employment in Renewable Energy Activities - Australia

This decline in FTE employment in renewable energy activities has mainly occurred due to a decrease in the number of roof-top solar photovoltaic (PV) systems being installed on the roofs of homes (over a 60% decrease between 2011-12 and 2015-16) (Clean Energy Regulator, 2016).

This decline in installations has led to a similar sized decrease in FTE employment in the installation of roof-top solar PV (which includes solar hot water systems) over the same period (see Figure 2).

Figure 2 - Annual direct FTE employment in Roof-top Solar activities in Australia, 2009-10 to 2015-16 (a)

Footnote(s): (a) Includes Solar Hot Water systems

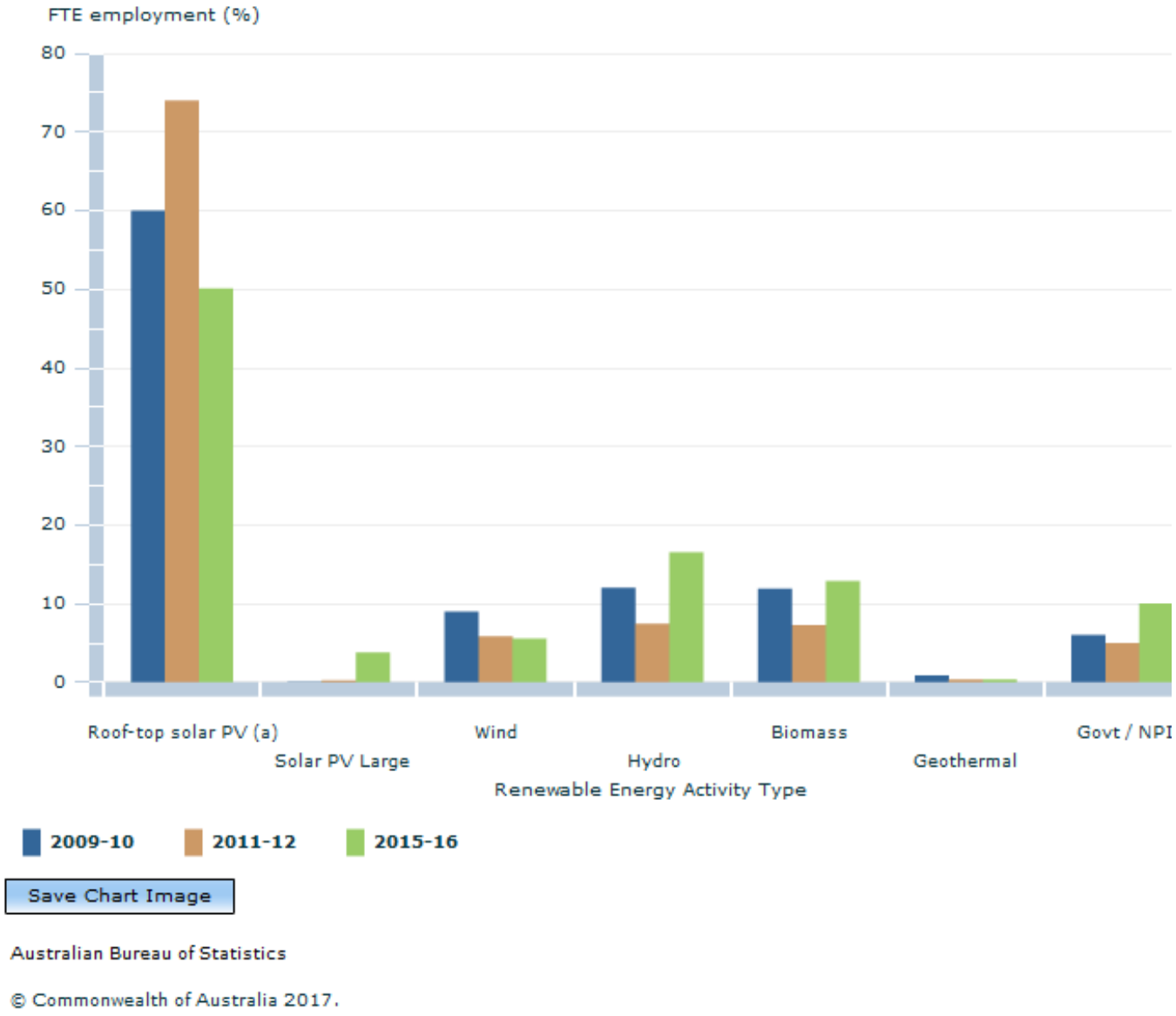
Source(s): Employment in Renewable Energy Activities - Australia

Employment in renewable energy activities is influenced by policies put in place by federal, state/territory and local governments. In order to facilitate analysis, a description is provided within the Explanatory Notes to this publication of some relevant key government policies operating during the period 2009-10 to 2015-16.

TYPE OF RENEWABLE ENERGY

Among renewable energy activities, employment in roof-top solar photovoltaic (PV) systems (which also includes solar hot water systems) made up the largest component of total direct annual FTE employment in 2015-16 with 5,570 or 50% of all such employment. Though employment in this category fluctuated during the period from 2009-10 to 2015-16, it remained the largest single contributor to employment in renewable energy activities throughout this period. Its share peaked in 2011-12 when employment in roof-top solar PV made up 74% of total direct FTE employment in renewable energy activities, as shown in Figure 3.

Figure 3 - Proportion of annual direct FTE employment by type of renewable energy 2009-10, 2011-12 and 2015-16



Footnote(s): (a) Includes Solar Hot Water systems

Source(s): Employment in Renewable Energy Activities - Australia

Employment in large scale solar and wind power is primarily driven by installation activity, rather than by ongoing operation and maintenance. As a result, this employment is heavily dependent on continuing formation of infrastructure and is relatively volatile. Total annual direct FTE employment in wind power has been varied, with a high in 2013-14 of 1,720 or 12% of annual direct FTE employment in renewable energy activities, to a low of 620 in 2015-16 (6% of the total).

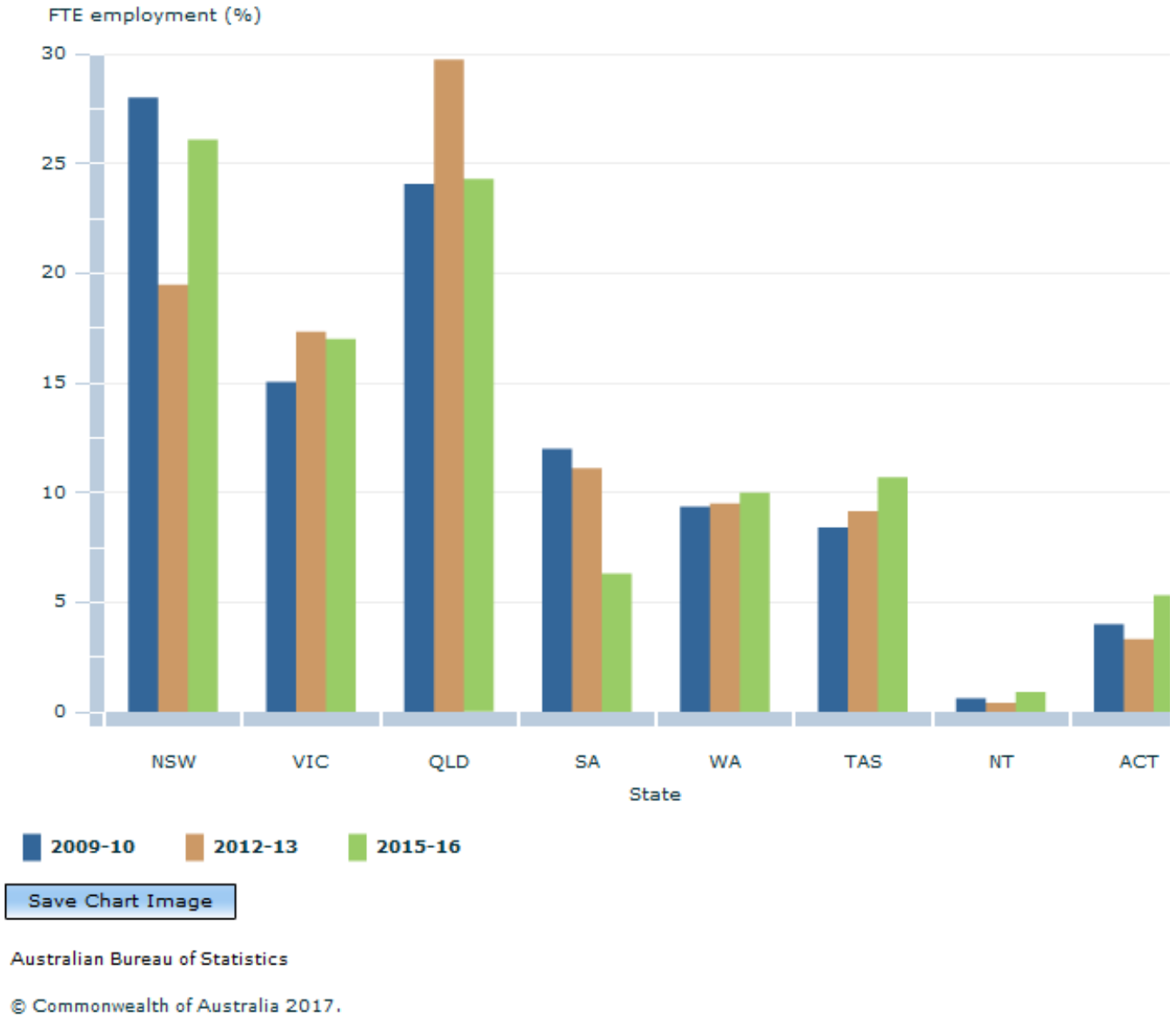
FTE employment in hydropower and government and non-profit institutions (NPIs) both increased between 2009-10 to 2012-13 but have remained fairly stable since then. FTE employment in biomass remained fairly stable throughout the entire reporting period.

STATES AND TERRITORIES

As Figure 4 shows, in 2015-16 NSW recorded the highest level of annual direct FTE employment in renewable energy activities of any state or territory in Australia, with 2,920 FTE employees or 26% of total employment in renewable energy activities in Australia. Queensland recorded 2,710 or 24% of total employment in renewable energy activities, Victoria 1,900 (17%), Tasmania 1,190 (11%), Western Australia 1,060 (10%) and South

Australia 710 (6%). The ACT recorded 550 FTE (5%) while the NT recorded 110 (1%).

Figure 4 - Proportion of annual direct FTE employment by state and territory 2009-10, 2012-13 and 2015-16



Source(s): Employment in Renewable Energy Activities - Australia

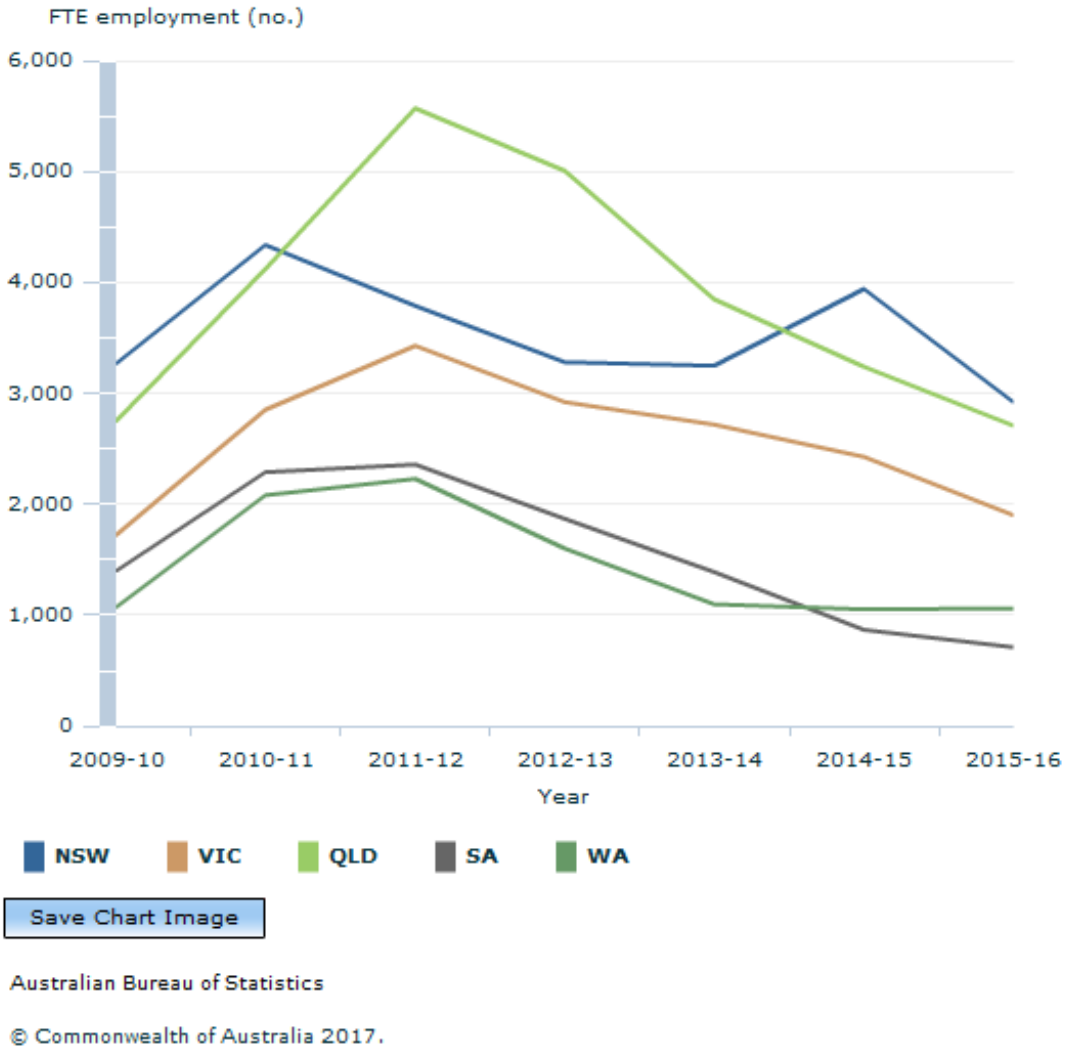
Figure 4 also shows how the proportion of annual direct FTE employment by state has changed over time. For example, in 2012-13 Queensland recorded the highest level of annual direct FTE employment in renewable energy activities among Australia's states and territories, with 5,010 or (30%) of all FTE employment in renewable energy activities.

Since the peak in annual direct FTE employment in renewable energy activities in 2011-12, most states have recorded an overall decline, particularly those states where employment in the installation of roof-top solar PV (including solar hot water systems) has been dominant. The largest fall in FTE employment occurred in Queensland, where employment fell from 5,570 to 2,710 between 2011-12 and 2015-16, a decline of 2,860 (51%). For the same period, South Australia experienced a fall of 1,650 (or 70%; from 2,360 to 710), Victoria a fall of 1,530 (or 45%; from 3,430 to 1,900), Western Australia a fall of 1,170 (or 52%; from 2,230 to 1,060) (see Figure 5.1).

Although NSW also experienced an overall fall in FTE employment between 2011-12 and

2015-16 (23%; from 3,790 to 2,920), the state did have an increase in jobs in 2014-15. This increase was due to the construction of several large scale solar farms (see Figure 5.1).

Figure 5.1 - Annual direct FTE employment in renewable energy activities - States, 2009-10 to 2015-16



Source(s): Employment in Renewable Energy Activities - Australia

For the same period, FTE employment in renewable energy activities in the ACT and Tasmania remained fairly stable, while the Northern Territory experienced a growth of 40 FTE jobs (57%; from 70 to 110). This growth in the Northern Territory was due to an increase in FTE employment in the solar industry (see Figure 5.2).

Figure 5.2 - Annual direct FTE employment in renewable energy activities - State and Territories, 2009-10 to 2015-16

Source(s): Employment in Renewable Energy Activities - Australia

TYPE OF RENEWABLE ENERGY, BY STATE/TERRITORY

The composition of employment in renewable energy activities varied somewhat between states and territories. However, for most states and territories, the major contributor to employment was solar power (which includes roof-top solar PV, solar hot water systems and large scale solar). As shown in Figure 6, Western Australia had the highest proportion of direct FTE employment related to solar power (93%). In NT (82%), Victoria (71%), SA (66%), Qld (54%) and NSW (53%), solar power also made up the majority of direct FTE employment in renewable energy activities in 2015-16.

Figure 6 - Proportion of FTE employment in solar power activities for each state and territory, 2015-16

Source(s): Employment in Renewable Energy Activities - Australia

Biomass makes a significantly greater contribution to total employment in renewable energy activities in Queensland than in any other state or territory. Employment in Queensland related to biomass renewable energy activities rose from 1,010 in 2009-10 to 1,150 in 2015-16 at which point it comprised 42% of the state's total employment in renewable energy activities. The Queensland sugar industry makes extensive use of the fibrous stalk of the sugar cane plant (bagasse) to generate electricity for use in sugar cane milling and for export to the electricity grid.

The main contributor to FTE employment in renewable energy activities in Tasmania is hydropower. In 2015-16, hydropower made up 87% of all FTE employment in renewable energy activities in Tasmania. In the ACT, the main contributor to FTE employment in renewable energy activities is government agencies and NPIs. In 2015-16, FTE employment in government agencies and NPIs made up 91% of all FTE employment in renewable energy activities in the ACT. Over the reporting period, FTE employment in hydro and government and NPIs has been more stable than other renewable energy activities, such as solar and wind. Therefore, FTE employment in both the ACT and Tasmania has remained fairly stable over the same time period (see Figure 5.2).

PENETRATION OF ROOF-TOP SOLAR PV ACROSS AUSTRALIA

Levels of employment involved in the installation of roof-top solar PV systems are influenced

by a number of government policies, including taxes, subsidies, pricing policies and renewable energy targets. The Explanatory Notes to this publication provide additional detail on the key influences affecting FTE employment in roof-top solar over time.

This section provides a broad picture of the penetration of roof-top solar PV systems into Australia's stock of private dwellings. The Clean Energy Regulator reports on the number of roof-top solar PV systems installed in Australia as at the end of Dec 2016 (in excess of 1.6 million). The ABS Census of Population and Housing provides numbers of dwellings in Australia, by state and territory and by type of dwelling structure.

Table 1 shows that across Australia, 21% of suitable private dwellings are equipped with a roof-top solar PV system. A suitable dwelling is defined as a separate house or as semi-detached row or terrace house. This penetration of roof-top solar PV varies markedly across states and territories, for example, in Queensland 32% and South Australia 31% of suitable private dwellings host a roof-top solar PV system, while just 13% of suitable private dwellings in Tasmania and 11% in the Northern Territory do so.

Table 1: Percentage of suitable dwellings with roof-top solar PV (a)

	December 2016 (%)
New South Wales	16
Victoria	15
Queensland	32
South Australia	31
Western Australia	25
Tasmania	13
Northern Territory	11
Australian Capital Territory	14
Australia	**21**

(a) A suitable dwelling is defined as a separate house or as semi-detached row or terrace house.

Not all types of dwelling structures are suitable for hosting roof-top solar PV systems, for example, caravans, tents and many units and apartments. Also, even though some detached houses, terrace houses and townhouses have the structural capacity to host a roof-top solar PV system it may not be practical to do so, due to issues such as a poor solar aspect. It is not possible to exclude such dwellings as they cannot be separately identified.

The average size of an installed roof-top solar PV system in Australia is currently just under 4 kW in capacity. In recent years, driven largely by falling prices for solar PV panels, the average size of systems has increased and are often over 5 kW in capacity (Clean Energy Council, 2016).

ELECTRICITY: ENERGY PRODUCTION AND EMPLOYMENT

Table 2 compares energy production and employment for the electricity supply industry and for selected types of renewable electricity production.

Table 2: Electricity generation and employment, by type of electricity production, 2009-10 to 2014-15

	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15

	Electricity Production (PJ)					
Total electricity production (PJ)(a)	**908**	**896**	**892**	**888**	**888**	**901**
Selected renewables						
Solar (a)	11	15	21	27	31	36
Wind (a)	18	21	22	29	37	41
Hydro (a)	49	61	51	66	66	48
Bagasse (b)	4	4	4	4	5	5
Renewable Energy Total	**82**	**101**	**98**	**126**	**139**	**130**
	Employment (000) (c)					
Total employment in industry (d)	**60.1**	**66.0**	**65.1**	**69.4**	**63.6**	**64.8**
Selected renewables (c)						
Solar	7.0	12.0	14.4	11.2	8.3	7.7
Wind	1.1	1.6	1.1	1.4	1.7	1.2
Hydro	1.4	1.4	1.4	1.7	1.8	1.8
Bagasse	0.9	0.9	0.9	0.9	1.1	1.1
Selected Renewables Total	**10.4**	**15.9**	**17.8**	**15.2**	**12.9**	**11.8**

(a) Data are sourced from Energy Account, Australia, 2014-15 (cat. no. 4604.0).
(b) Data are sourced from Clean Energy Regulator, National Greenhouse and Energy Reporting Scheme (NGERS).
(c) Electricity production from Energy Account, Australia (cat. no. 4604.0) is available for years up to and including 2014-15. Therefore, employment data in this table applies a matching time series.
(d) Data are sourced from Labour Force, Australia, Detailed, Quarterly (cat. no. 6291.0.55.003).

Table 2 shows that total production of electricity within the Australian economy fell each year between 2009-10 and 2013-14, from 908 PJs to 888 PJs but has increased again in 2014-15 to 901 PJs (Energy Account, Australia (cat. no. 4604.0)). In the same time period, total employment in the electricity supply industry (including both renewable and non-renewable electricity supply) rose from 60,100 in 2009-10 to a peak of 69,400 in 2012-13, before falling to 64,800 in 2014-15 (Labour Force, Australia, Detailed, Quarterly (cat. no. 6291.0.55.003)). Therefore, there has been an overall increase in jobs between 2009-10 and 2014-15 in the electricity supply industry even though electricity supply was decreasing for most of that time period.

In comparison, electricity generated from selected renewable sources (solar, wind, hydropower and bagasse) has risen by 59% between 2009-10 and 2014-15 (Energy Account, Australia (cat. no. 4604.0)). In the same time period, employment related to electricity production for selected renewables has risen from 10,400 in 2009-10 to a peak of 17,800 in 2011-12, before falling to 11,700 in 2014-15. A contributing factor to the rise in renewable energy employment between 2009-10 and 2011-12 is most likely due to the employment of construction workers to build renewable energy facilities. However, once construction is completed and only ongoing maintenance is required, employment falls quite significantly, even though generation of renewable electricity remains higher.

Comparisons between total employment in the Electricity Supply industry from Labour Force, Australia, Detailed, Quarterly (cat. no. 6291.0.55.003) and employment in renewable energy activities reported in this publication must be compared with caution. This is because 'Total electricity supply' in Labour Force, Australia is defined according to Australian and New Zealand Standard Industrial Classification (ANZIC) and therefore includes only employment within those units predominantly engaged in electricity production and supply - including production and supply of electricity from renewable sources. For example, it includes employment in electricity supply sourced from hydro power and from solar farms. It does not include employment required to build electricity power infrastructure. In contrast, the selected renewable employment estimates are taken from this publication and include

for example employment related to the construction of renewable energy infrastructure by employees of construction entities.

Introduction

INTRODUCTION

In recent years, Australia has experienced growth in the amount of energy derived from renewable energy sources. The Australian Bureau of Statistics (ABS) Energy Account, Australia 2014-15 (cat. no. 4604.0) released in February 2017, reports that 337PJ of energy was supplied from renewable sources in 2014-15, up from 258PJ in 2008-09. While the proportion of energy supplied from renewable sources in Australia remains small (1.5% in 2014-15), there is considerable interest in renewable energy including interest in the amount of employment associated with renewable energy activities. This publication contains estimates of annual direct full time equivalent (FTE) employment in renewable energy activities. Estimates relate to the years 2009-10 to 2015-16 for Australia and its states and territories. This project was funded by the Australian Renewable Energy Agency (ARENA).

There are no comprehensive international statistical standards to guide the definition and measurement of employment in renewable energy activities and therefore the development of this publication has had to resolve a number of questions and challenges without the benefit of a guiding standard. The primary challenge is that renewable energy activities take place across a range of industries and there is no agreed definition of the renewable energy industry. In measuring employment by an industry, conventional practice is to first assign each business to an industry, based on the predominant activity of the business. Employees are then deemed to belong to the industry to which their employer has been assigned. Thus, the measurement of employment by industry is in concept relatively straightforward for standard industries such as mining, manufacturing or retail trade. On the other hand, measuring employment for non-standard industries, such as renewable energy, tourism or information and communication technologies (ICT), requires careful consideration and definitions of what is being measured and of the supporting methodologies.

An important role of this publication is to establish guiding principles for understanding employment in renewable energy. These guidelines have been established in large part by following general accounting principles embodied in relevant international statistical standards: the 2008 edition of the System of National Accounts (2008 SNA) and the 2012 Central Framework of the System of Environmental-Economic Accounting (SEEA-CF). Estimates are also consistent with Guidelines concerning a statistical definition of employment in the environmental sector produced by the International Labour Organisation. Appendix 1 of the Guidelines describes how relevant international statistical standards have been interpreted and used to develop a notion of employment in renewable energy activities.

The International Renewable Energy Agency (IRENA) in Renewable Energy and Jobs (2013) publishes estimates of employment in renewable energy at global, regional and national levels. IRENA acknowledges the difficulties of drawing together disparate data on employment in renewable energy activities but does not offer a precise definition of renewable energy employment. Similarly, national estimates of employment in renewable energy jobs, both official and unofficial, typically provide only limited detail on those activities deemed to be 'renewable energy' activities. This publication systematically identifies, for each renewable energy type, the main activities considered to be in scope of employment in

renewable energy activities. These activities typically range from manufacturing of equipment specific to renewable energy; installation of renewable energy infrastructure; and the operation and maintenance of this infrastructure. This publication includes employment in government agencies and non-profit institutions (NPIs) where this employment is predominantly motivated by the support of renewable energy.

Appropriate estimation methodologies are required to support estimates of employment in renewable energy activities. National statistical agencies do not typically collect information on renewable energy employment directly from survey respondents since the burden on survey respondents and on statistical agencies can be considerable, especially given the difficulties in identifying an appropriate list of employing businesses. These difficulties stem in large part from the fact that renewable energy is not a standard industry, but also from the great heterogeneity of businesses engaged in renewable energy activities. However, in recent years a range of techniques to develop estimates of employment in renewable energy activities has been used across a number of countries. The ABS has estimated employment in renewable energy activities by using two such techniques: firstly, by accessing information made publicly available on websites by renewable energy providers; and secondly by utilising employment factors. The latter technique uses information on how much energy is produced by renewable energy installations, numbers of installations and specific employment factors. Employment factors indicate the number of annual direct FTE jobs created per physical unit of choice. The technique is described more fully in the Explanatory Notes.

The estimates contained in this publication represent the outcome of development work requiring the use of assumptions and synthetic estimates for some data components and are considered experimental. In particular, estimates published in the first release of this publication contained several known omissions that were substantially addressed in the subsequent editions. For example, the second edition included employment related to the use of bagasse (a waste by-product of sugar cane milling) for electricity production. In this, the third edition, the methodology to determine hydro was revised to include more reliable data provided by hydroelectricity retailers. In identifying and delivering these changes the ABS sought and received valuable input from the statistical user community, in particular from industry experts and from relevant government agencies.

The ABS hopes that future editions of this publication will continue to benefit from the input of interested parties from industry, government, academia and the general community. As such, the ABS welcomes feedback on the estimates contained in this publication. Comments may be directed to <environment@abs.gov.au> or in hardcopy to:

Director, Accounts Development, Environment and Agriculture Statistics Branch
Australian Bureau of Statistics
Locked Bag 10
Belconnen, ACT, 2616.

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Changes in this issue

CHANGES IN THIS ISSUE

The ABS has made a number of changes in this issue. These are described below and reflect ongoing ABS research into the measurement of employment in renewable energy activities, supported by valuable feedback received from industry experts and government sources. The ABS is grateful for the user feedback received to date and will continue to actively seek stakeholder input.

CHANGES TO BIOMASS

Employment in biomass has been revised upwards for all years of the reported time series. These revisions are driven mainly by the revision of employment activities related to the production of electricity from bagasse based on more reliable data inputs.

CHANGES TO HYDRO-ELECTRICITY

Employment in hydro-electricity was reviewed following the use of more reliable data provided by a hydroelectricity retailer. The relevant time series was revised using the new data and had a small impact on the results.

CHANGES IN SOLAR

A new data source was used to calculate the number of installations of small scale roof-top solar and solar hot water heater units in 2015-16. This change has replaced the need to use estimation methods and therefore has made the data more reliable.

CHANGES IN GOVERNMENT AND CHANGES IN GOVERNMENT AND NON-PROFIT INSTITUTIONS (NPIs)

Employment in Government and NPIs was reviewed following the discovery of more reliable data for some government bodies. The relevant time series was revised using the new data and had a small impact on the results. This impact was most notable in the ACT.

About this Release

This is the third release of Employment in Renewable Energy Activities, Australia. It reports on Full Time Equivalent (FTE) employment in renewable energy activities. Estimates are produced in respect of the years 2009-10 to 2015-16, by state and territory and by type of renewable energy activity. These estimates update and replace those contained in the first and second release of Employment in Renewable Energy Activities, Australia.

Explanatory Notes

Explanatory Notes

EXPLANATORY NOTES

RENEWABLE ENERGY EMPLOYMENT

Definition and scope

1 In this publication renewable energy employment is defined as **employment in activities principally motivated by the production of renewable energy, and/or by the design, construction and/or operation and maintenance of renewable energy infrastructure**. These renewable energy activities are carried out within institutional units and for some of these units, renewable energy activities are its predominant activity. In other cases, the renewable energy activity occurs as a secondary activity of the institutional unit. Nevertheless, employment related to all such renewable energy activities is in scope of this publication.

CATEGORIES OF RENEWABLE ENERGY

2 Renewable energy may be generated from a number of sources. Within Australia the **Renewable Energy (Electricity) Act 2000** describes the range of renewable energy sources eligible under this act and these form the basis of renewable energy types contained in this publication. The broad categories of renewable energy types are:

- Solar - Roof-top photovoltaic (PV)
- Solar - Hot Water System
- Solar - Large scale
- Wind
- Hydro
- Biomass
- Geothermal
- Wave

3 In addition, a significant number of employees of government bodies and non-profit institutions (NPIs) are engaged in activities directly and predominantly motivated by the promotion, administration and production of renewable energy and of renewable energy infrastructure. Within this publication the following additional category of renewable energy activity is included:

- Government and non-profit institutions (NPIs).

4 Government and NPI employees are recorded separately from the other categories of renewable energy, since these employees are typically engaged in activities that cut across various types of renewable energy. For example, an employee of the Clean Energy Regulator who carries out tasks related to the administration of Australia's renewable energy target is principally motivated by the delivery of a market infrastructure to promote all types of renewable energy. Since Australia's renewable energy target promotes a range of renewable energy types, it is not appropriate to assign employees of an entity such as the Clean Energy Regulator to a specific type of renewable energy. Instead, they are assigned to a separate category 'Government and NPIs'.

SCOPE OF RENEWABLE ENERGY ACTIVITIES

5 This section briefly describes the scope of activities included under each category of renewable energy and for government and NPIs. Direct full time equivalent (FTE)

employment in renewable activities relates specifically to the following activities.

Solar - Roof-top photovoltaic (PV)

6 Employment in solar roof-top PV activities extends to all activities required to install small scale solar power infrastructure. This includes such activities as site preparation; roof modifications; electrical preparations (e.g. powerboard upgrade and/or meter replacement); installation of racking for solar panels, solar panels and inverter; and testing and certification of installed systems. It also includes related retail activities and project management. Employment in operation and maintenance of roof-top solar PV is in scope, however no estimates have been made of employment in these activities because it is assumed to be insignificant due to the low maintenance generally required for this infrastructure and the low average age of solar panels currently installed in Australia.

7 Note that while these activities are described as relating to 'roof top PV' solar, in fact they include employment activities related to all solar PV systems with the exception of those related to the category of Solar - large scale.

Solar - Hot water system

8 Employment in solar hot water system activities includes installation of solar hot water systems (HWS), either into new dwellings; or into existing dwellings as a replacement for existing solar HWS or as retrofitted conversion to solar HWS. Direct employment in renewable energy activities relates to those employment activities needed to carry out the installation of the solar HWS, for example, site preparation, system design, system installation, project management and administration. It also includes manufacturing of solar HWS in Australia, as well as repair and maintenance activity carried out on installed solar HWS.

Solar - Large scale

9 Employment in large scale solar activities includes employment activities related to all solar power systems with an installed capacity of 40kW or greater. The estimation methodology used in this publication for employment in large scale solar activities requires the creation of a listing of all large scale solar operations in Australia. The data source used to create this listing applies a cut-off point of 40kW and the estimates contained in this publication observe the same cut-off. In practice, large scale solar includes two broad types of solar power infrastructure. The first is a larger version of household roof-top solar PV installations, typically sited on the roof of commercial operations such as shopping centres, hospitality clubs or factories. The owner of this type of infrastructure is usually seeking to defray a significant electricity expense. The second type of large scale solar infrastructure is a dedicated solar farm allowing the electricity producer to supply electricity to the grid for sale to third-party customers. This type of infrastructure will allow its owner to gain accreditation under the Large-scale Renewable Energy Target (LRET). In both cases, employment in renewable energy activities relates to those direct employment activities needed to carry out the installation of large scale solar, such as site preparation, system design, system installation, project management and administration. In principle, it also includes employment related to the ongoing operation and maintenance of large scale solar power infrastructure.

Wind

10 Employment estimates for wind power encompass two broad areas of activity: installing wind power infrastructure such as concrete slabs, towers, turbines, grid connection and access roads; and the ongoing technical operation and maintenance of wind power

infrastructure. The former is primarily undertaken by employees of engineering and construction, transport and similar businesses. The latter is typically carried out by employees of the wind power infrastructure operator. Small scale roof-top wind turbines are also a form of wind power generation. However, employment in small scale wind has not been included in this publication as only a very small number have been installed over the reporting period and it is currently not a widely utilised technology.

Hydro

11 Employment in hydropower activities includes all activities required to carry out hydropower operations, including those related to operating and managing hydropower assets to generate hydroelectricity. In addition to the range of technical activities needed to carry out these operations, hydropower activities include such things as related retail activity; engagement with local and national electricity markets; management of environmental assets and engagement with various hydropower stakeholders. Planning and construction of hydropower capital works are also in scope, and these activities include the construction and/or upgrade of dams for hydropower; upgrade and/or replacement of key technical components such as turbines and transformers; and capital works related to distribution assets such as grid connections, poles, wires and other distribution structures.

12 This category also includes employees involved in designing, developing and installing micro hydro power infrastructure.

Biomass

13 Energy from biomass includes bagasse (fibrous sugar cane waste); bio ethanol; bio diesel; gas from landfill; sewage gas; and crop and livestock waste. Direct employment in biomass energy activities includes the design, construction and maintenance of infrastructure used to create energy from biomass. It also includes employees who operate this infrastructure for the primary purpose of generating renewable energy.

14 Direct employee numbers for biomass do not include those engaged in cultivating biomass feedstock, such as red sorghum or sugar cane, for use in generating bio-energy. It also does not include employees engaged in pulp and paper manufacturing - a process in which black liquor may be created as a renewable energy by-product. The primary reason for pulping wood chips under a kraft milling process is to support the production of paper products; the creation of black liquor is a secondary (though valuable) outcome. This is also the case for red sorghum and sugar cane as they are primarily grown for other purposes and renewable energy is created as a secondary product.

15 However, the use of bagasse (fibrous sugar cane waste) to generate electricity can and does give rise to direct employment in biomass energy activities. A number of sugar mills in Australia continue to operate beyond the conclusion of the sugar cane crushing season at which point their output is made up exclusively of electricity sold to the grid. At this point in time, the employees in these mills are engaged in activities principally motivated by the production of a renewable energy product. Employment in these mills, in the period outside the sugar cane crushing season, is thus treated in this publication as employment in renewable energy activities.

Geothermal

16 At present, employment in geothermal power activities relates to the development of geothermal energy infrastructure i.e. site preparation, system design, drilling, system installation, related transport activity, project management and administration. Australia's geothermal energy operations remain essentially exploratory exercises with only limited

operational capacity developed to date.

17 Academic research into geothermal energy is concentrated into dedicated centres located within Australian universities. Employees engaged in these activities have been assigned to the category 'government and NPIs'.

Wave

18 The use of ocean waves, tides or current to generate energy is currently at early production stages within Australia. Renewable energy activities relevant to estimates of direct employment in wave energy include the design, construction and operation and maintenance of wave energy infrastructure.

19 Employment in this area is small and there is very little publicly available data on employment in wave energy activity in Australia. As a result it was decided to omit estimates of annual direct FTE employment in wave energy activities.

Government and non-profit institutions (NPIs)

20 The scope of this publication includes activities undertaken by employees of government agencies and NPIs to support the operation of renewable energy systems, for example, administration, legal, policy or advocacy. Therefore, employment in regulatory bodies such as the Clean Energy Regulator is in scope. Some government agencies and NPIs provide support that is critical to the go-ahead of many renewable energy projects and the employees of these units are also considered to be renewable energy employees. Examples of the latter include the Clean Energy Finance Corporation (CEFC) and ARENA. Employees engaged in renewable energy advocacy are also included, for example, employees of peak bodies in various renewable energy sectors.

DIRECT / INDIRECT EMPLOYMENT IN RENEWABLE ENERGY ACTIVITIES

21 International statistical standards do not define direct and indirect employment; however, the concepts are straightforward for standard industries. For example, direct employment in the mining industry refers to jobs created by the actions of units predominantly engaged in mining activity.

22 The concept becomes less straightforward in the context of non-standard industries, or for specific projects. For example, no 'Tourism' industry exists within standard industry statistics produced by official statisticians. Tourism is defined in terms of the consumer of the product such that, for example, some consumers of accommodation services are engaged in tourism activity and some are not. Thus, it is difficult to determine where 'tourism' employment starts and finishes. In the case of tourism, the direct effect relates solely to the immediate effect of expenditure made by visitors. For example, when a tourist uses a taxi service, the direct employment effect includes the proportion of the driver's employment that is spent driving tourists. The indirect effects on employment would include employees hired by the petrol stations, garages and food outlets needed to provide the taxi driver with petrol, motor servicing and meals while on duty. Renewable energy activity, like tourism, does not constitute a standard industry within industrial classifications.

23 Direct employment in renewable energy activities is employment directly related to the production of renewable energy, and/or by the design, construction and/or maintenance of renewable energy infrastructure. The section above 'Scope of renewable energy activities' describes the specific activity inclusions for each type of renewable energy. For example, an installer of roof-top solar PV will undertake a range of activities to design and install this

infrastructure. That is, direct employment relates to such activities as site preparation; roof modifications; electrical preparations (e.g. powerboard upgrade and/or meter replacement); installation of racking, solar panels and inverter; and testing and certification. It includes any subsequent call-out for repairs and maintenance, and also retail activities and project management. Indirect employment comprises all people who work in the production of intermediate inputs related to installing, operating and maintaining renewable energy infrastructure. It arises from such things as general supplies used in the installation process (e.g. wiring, conduit, replacement roof tiles), servicing of transport equipment, meals consumed on the job and so on. If the installer of roof-top solar PV does general electrical work such as replacing powerpoints or light fittings, this is not employment in renewable energy activities (of either a direct or indirect kind).

ESTIMATION METHODOLOGY

24 Renewable energy is not readily discernible from the standard product and industry classifications used within official statistical series. For example, within the 2006 edition of the Australian and New Zealand Standard Industrial Classification (ANZSIC), 2006 (cat. no. 1292.0), renewable energy is separately identified within Class 2612 **Hydro-Electricity Generation**, but no other renewable energy activity is separately identified in this way. Units whose predominant activity is to generate electricity from wind, solar, biomass, geothermal or wave energy are not separately identified but are recorded together within ANZSIC Class 2619 **Other Electricity Generation**. In cases where renewable energy is not the predominant activity of the producing unit, for example, the use of black liquor by some paper manufacturers, standard industry statistics will instead record economic activity against the predominant activity of the unit. The installation of renewable energy infrastructure is an important example of ANZSIC treating activity not as part of a renewable energy industry but instead as construction activity or as professional, scientific and technical services. The cross-cutting nature of renewable energy means that, while renewable energy activity is in scope of the national accounting framework, it is captured in a way that does not support its full and separate identification.

25 National statistical agencies do not typically conduct surveys on renewable energy activities. In producing the experimental estimates contained in this publication the ABS has used three broad approaches. These approaches are as follows:

- Accessing publicly available information such as company annual reports, information provided on company websites, industry association reports and data drawn from the Renewable Energy Certificate (REC) Registry maintained by the Clean Energy Regulator.
- Making use of the employment factor approach (discussed below).
- Using employment numbers provided directly by the institutional unit.

Employment factor approach

26 The employment factor approach has been used to estimate employment in renewable energy activities by type of renewable energy. It utilises information on installed capacities of renewable energy infrastructure (i.e. how much renewable energy is produced by renewable energy infrastructure), numbers of installations and employment factors. Employment factors indicate the number of annual direct full time jobs created per physical unit of choice, for example, numbers of annual FTE employees created per megawatt (MW) of installed capacity of wind power. It is an estimation technique that has been used internationally to generate employment numbers associated with renewable energy activities.

27 The critical element of this methodology is the employment factor itself and this has been estimated on the basis of specific case studies, industry surveys, feasibility studies and technical literature specifications related to renewable energy operations.

28 The employment factors used in this publication make use of an international summary of factors published by the International Renewable Energy Agency (IRENA) in Renewable Energy and Jobs (2016), augmented by a number of Australian studies. The actual employment factors used within this publication are described in the section immediately below, against the relevant categories of renewable energy.

29 Employment factors vary significantly over time and from country to country and must be interpreted and used with caution. They reflect different employment functions inherent within different countries, leading to significant variation in employment numbers per unit of installed capacity of renewable energy. For example, the lower price of labour in developing countries often results in significantly more FTE employment per MW of installed capacity than is the case for high labour cost developed countries. Employment functions would be expected to change over time, sometimes quite rapidly, as technological improvements are achieved in renewable energy equipment and as the technical expertise of designers, managers and installers grows.

ESTIMATION METHODOLOGY, BY TYPE OF RENEWABLE ENERGY

Solar - Roof-top PV

30 The employment factor approach was used to estimate annual direct FTE employment associated with roof-top solar PV power.

31 The Clean Energy Regulator reports information on installed capacity of roof-top solar PV infrastructure in Australia. The number of installations is typically used for the calculation of employment estimates using the employment factor approach.

32 A number of countries have developed estimates of employment related to the installation of roof-top solar PV by using employment factors expressed per MW of installed capacity of solar PV (IRENA, 2013). These data were compared to data yielded by recent Australian case studies which show significantly lower levels of employment per MW of installed capacity than typically reported overseas. There are a number of reasons for these differences. In the first instance, the Australian figures assume that no domestic employment arises from the manufacturing of solar components (panels, inverters, racking etc.) and this assumption does not hold true for some other countries. A second more critical factor is the age of many of the international estimates. Given the dramatic recent decline in the price of roof-top solar PV components, it has become more affordable to install larger systems. With the recent growth in the average size of roof top solar PV systems installed, annual employment per MW of installed capacity has also fallen greatly.

33 On the basis of case study investigations the ABS has determined that in using the employment factor approach, the more meaningful physical variable is employment per roof-top solar PV system installed, rather than per MW of installed capacity of roof-top solar PV. Larger roof-top solar PV systems have more solar panels and more racking and their installation therefore requires somewhat more labour. However, the majority of tasks making up a roof-top solar PV system installation take equally long to complete for a small system as for a large one. For example, time spent on sales activity; project management; processing of renewable energy certificates (RECs); transport to and from the work site; roof preparation; installation of inverter; upgrade of powerboard; replacement of electricity meter and regulatory checks; are either completely or largely independent of the size of the roof-

top solar PV system installed.

34 The average size of a roof-top solar PV system installed in Australia increased substantially between 2009-10 and 2015-16. The estimation methodology used by the ABS recognises that roof-top solar PV systems are now larger and therefore take longer to install. Equally, it is recognised that over this brief time series efficiency gains have been made in the installation of roof-top solar PV systems.

35 The ABS case study findings focussed specifically on the labour required at the work site to install roof-top solar PV infrastructure. To this is added employment associated with various 'business process costs' (e.g. sales, planning and administration costs) needed for the installation of roof-top solar PV. The scaling up of employment factors to include these 'business processes' has been carried out using figures sourced from the International Renewable Energy Agency (IRENA 2012, p20) and from discussions with experts on the operation of the Australian solar power industry.

Solar - Hot water system

36 The employment factor approach was used to estimate annual FTE employment associated with the installation and servicing of solar hot water systems.

37 Estimates of the number of solar hot water systems installed, both cumulatively and for individual years, is based on data from the **Clean Energy Regulator**. The employment factor is based on case study information and on publicly available information and is expressed as hours worked per installation of solar hot water system. The factor used considers employment activities related to the installation of solar hot water systems and to the manufacture of such units within Australia. Note that installations made to an existing home will take longer than an installation to a new dwelling and that the employment factor also considers ongoing servicing of solar hot water systems.

Solar - Large scale

38 The employment factor approach was used to estimate annual FTE employment associated with large scale solar power.

39 Limited information is available internationally on employment factors per MW of installed capacity of large scale solar power. This may be explained by the fact that, until recently, large scale solar struggled to compete on cost grounds with other forms of renewable energy, particularly wind. Instead, international data on employment per MW of installed capacity was more likely to pertain to the installation of roof top solar PV and other applications of solar power. As is the case for wind power, most of the data available internationally on employment per MW of installed capacity of solar power appear considerably higher than could be justified for the Australian context.

40 Several large scale solar power operations have recently been either proposed or completed in Australia. Typically the owners have established public websites providing extensive information on the scale and nature of these operations, including details on employment. By using a combination of this publicly available information, assumptions about the relationship between jobs and annual FTE employment, and by incorporating an element of employment related to the planning and development of the solar farm, it has been possible to derive an employment factor expressed as annual FTE employment per MW of installed capacity of large scale solar power.

41 The employment factor used by the ABS for large scale solar power is at the lower end of the spectrum of international observations. However, it is comparable to the estimate

generated by the European Photovoltaic Industry Association (September, 2012).

42 Large scale solar encompasses a wide range of operations, from 40kW capacity roof-top solar systems to solar farms with upwards of 100 MW of capacity. It has been found that, in practice, employment per MW of installed capacity does not vary significantly between roof-top solar PV and large scale solar farms.

Wind

43 The employment factor approach has been used to estimate annual direct FTE employment for wind power.

44 A list of relevant businesses engaged in wind power operations was compiled using publicly available information. This list contains data on each wind farm in Australia, including: state/territory; start/finish date of construction activity; and installed capacity of the wind farm. Employment factors were generated for: direct FTE annual employment related to construction activity; and direct FTE annual employment related to ongoing operation and maintenance of the wind farm. The employment factors were determined based on various Australian studies, taking into account information publicly released by a number of companies installing wind power in Australia, and after consideration of published results from around the world.

45 The employment factors used in this publication were selected after confrontation with other available data, in particular, after comparison with information publicly released by a number of Australian companies delivering and operating renewable energy projects. Official company reports and website information on renewable energy projects frequently set out expected and actual employment levels related to these projects, as well as project start and finish dates and installed capacity in MW. These figures were used to derive observed estimates of employment factors for specific projects and to help determine which employment factors were the most appropriate to Australian operations for the period in question. The employment factors used for wind power in this publication are at the lower end of the range of factors published internationally.

46 A high priority was placed on obtaining recent observations because the recent rapid increase in size of wind turbines and blades impacts directly on per-MW employment factors. In addition, Australia's status as a high wage cost country necessarily restricts useful comparisons to employment factors from similarly high wage cost countries i.e. where greater pressure exists to maintain the minimum workforce necessary to complete the task. Employment factors used in many overseas studies include a large manufacturing component but for Australia the amount of employment related to manufacturing of renewable energy equipment is much less. This is further justification for use of employment factors that are at the lower end of the spectrum of international data. Finally, employment factors used for wind power in this publication do not consider employment related to decommissioning or refurbishment of renewable energy infrastructure, primarily because most of Australia's renewable energy infrastructure is relatively young and very few wind power operations have ended their productive life.

Hydro

47 The estimation process used a list of Australia's active hydropower sites compiled from a range of sources available from public websites.

48 In Australia, hydropower operations are typically carried out by large enterprises predominantly engaged in the provision of hydropower. For these enterprises, employment data were taken from publicly available annual reports and from other information publicly

available on related websites. However, there are also enterprises that predominantly rely on power from a range of sources that include hydropower operations as part of their energy mix. For these enterprises, employment data were mainly obtained from information publicly available from their websites. In some cases, however, employment numbers could not be retrieved from websites and were instead supplied directly from the enterprise, or estimated based on the installed hydropower capacity of the operations.

49 For two hydropower operators the ABS has adjusted information taken from publicly available sources. These adjustments are explained below.

50 The Hydro Tasmania 2016 Annual Report presents employee numbers by calendar year, up to 2016. An estimate of Hydro Tasmania employees engaged in wind farm activities has been deducted from this total. This adjusted calendar year series has been converted to a June 30 financial year basis using the average of adjoining calendar year estimates.

51 An adjustment was also applied to employment data released in respect of 2012-13 by Snowy Hydro Limited on its company website. In order to extrapolate beyond 2012-13 to 2014-15, an indicator was built to approximate movements in FTE employees of Snowy Hydro. The indicator is 'Employee Benefits Expense' taken from annual reports of Snowy Hydro, divided by average hourly cash earnings of full-time non-managerial adult employees of the Electricity supply industry, sourced from the ABS publication Average Weekly Earnings, Australia (cat. no. 6302.0). For 2015-16, the 2014-15 estimates have been extrapolated.

Biomass

52 Estimates of annual FTE employment in energy from biomass are derived in three ways: by using publicly available employment estimates, by using the employment factor approach and by sourcing FTE estimates directly from biomass producers.

53 Four distinct sets of estimates make up employment in energy derived from biomass: bagasse, bio ethanol, bio diesel and landfill gas. Employment related to the use of bagasse is estimated using publicly available information on the export of electricity to the grid by sugar mills and on the numbers of employees of such mills. For bio ethanol and bio diesel production, employment data are obtained substantially from publicly available information. In some cases, employment has been estimated based on the installed capacity of the plant, given knowledge of employment numbers for similar sized operations.

54 Employment in landfill gas includes both design/installation of landfill gas infrastructure and ongoing operation and maintenance of this infrastructure. Publicly available information provided estimates of employment in the design and installation of landfill gas infrastructure. A number of landfill gas operators have placed information on public websites regarding employment numbers and installed energy capacity. From these observations, an employment factor was derived and used for small landfill energy operations in Australia.

Geothermal

55 Employment in geothermal operations in Australia is primarily concerned with exploration and development activity. Estimates of annual direct FTE employment in energy derived from geothermal energy were derived from publicly available employment estimates.

56 A register of the limited geothermal power operations in Australia was created using information contained in **Australian Energy Resource Assessment** (footnote 1). (Department of Industry, Geoscience Australia and Bureau of Resources and Energy Economics). For these operations, estimates of employment were based on publicly

available web-based sources.

Government and Non-profit Institutions (NPIs)

57 Government agencies and NPIs generally freely provide good web-based information on their operations, including employee numbers. This was the principal source used for estimation of annual direct FTE employment in renewable energy activities within government and NPI units. Where information could not be sourced from publically available sources, employment numbers were supplied by the agency or NPI.

58 The estimates published here are likely to understate the true levels of renewable energy employment within government and NPIs. It is likely that a significant number of these entities employ numbers of people engaged in work directly related to renewable energy, for example, local council employees that develop and administer guidelines related to roof top solar systems, or employees of state government agencies that manage environmental aspects of wind farm proposals. This publication includes employment data where publicly available government information identifies an entire agency or an entire program engaged in renewable energy activities.

59 A number of universities, often in partnership with outside entities, undertake research and development related to renewable energy. Employment in these types of activities is included in this publication, for example, employment in developing understanding and design of geothermal operations. However, care has been taken to exclude employees engaged in energy efficiency developments, or in research related to institutional and/or economic aspects of renewable energy. Persons engaged in renewable energy activities under Doctoral or Visiting arrangements are also excluded from these estimates of FTE employment. Care has been taken not to double-count employees where university departments are working in partnership with industry.

60 A number of government and NPI employees are engaged in climate change related work, for example, through policy development, advice, training and inter-disciplinary collaboration. Although renewable energy is a central consideration of climate change policy, these employees are not specifically engaged in renewable energy activities and they have been excluded from the estimates contained in this publication.

KEY POLICY INFLUENCES ON RENEWABLE ENERGY EMPLOYMENT

61 Levels of employment in renewable energy activities are influenced by a number of government policies, including taxes, subsidies and pricing policies. Policies to enable the achievement of the Renewable Energy Target (RET) have an important influence on the uptake of all types of renewable energy and therefore on employment in renewable energy activities. The RET is comprised of the Large Renewable Energy Target (LRET) and the Small-scale Renewable Energy Scheme (SRES). Any uncertainty over the future of the RET, or over the size of the renewable power percentage, is likely to affect decisions on investment in renewable energy infrastructure.

62 The feed-in tariff (FiT) is another important influence on employment in roof-top solar PV activities. A FiT is a pricing arrangement under which an electricity supplier pays a customer for electricity that is generated by a solar PV system owned by the customer and exported (i.e. ‘fed-in’) to the grid. The FiT varies significantly over the time series presented in this publication, and between states and territories. During 2009-10 and 2010-11, the FiT paid to customers in most states and territories was higher than the normal wholesale cost of electricity generation, and sometimes in excess of the retail price of electricity. Commencing from 2011-12 significant reductions in FiT prices were introduced in the majority of states

and territories. These reductions coincide with falls in new installations of roof-top solar PV systems and in associated employment.

63 The amount of the FiT and its conditions of operation varies over the published time series and from state to state. One important condition of the FiT is whether it is paid on a gross or net basis. A gross FiT applies to the full amount of electricity produced by the customer while net FiT applies only to the excess of the customer's production over their consumption.

64 The following paragraphs summarise the operation of FiT arrangements within each state and territory over the time series of this publication.

65 The New South Wales (NSW) Solar Bonus Scheme introduced a gross FiT for energy generated from a roof-top solar PV system of less than 10 kW in capacity. This scheme commenced on 1 January 2010 with a FiT of 60 cents per kilowatt hour (kWh). In October 2010, this gross FiT was reduced to 20 cents per kWh and in April 2011 the Solar Bonus Scheme was closed to new applicants. Since April 2011 NSW has not mandated a minimum FiT. Instead, the NSW Independent Pricing and Regulatory Tribunal (IPART) have made a benchmark assessment each year since 2011-12 of the value of electricity provided by electricity customers back to the electricity retailer. However, retailers in NSW are free to set their own FiT and need not observe IPART's published benchmark range. IPART's benchmark range for the FiT was 8 to 10 cents per kWh in 2011-12, 7.7 to 12.9 cents per kWh in 2012-13, 6.6 to 11.2 cents per kWh in 2013-14 and 4.9 to 9.3 cents per kWh in 2014-15. In June 2016, IPART set the benchmark between 5.5 to 7.2 cents per kWh. The Solar Bonus Scheme in NSW ended on 31 December, 2016.

66 Victoria commenced a Premium Feed-in Tariff late in 2009, which offered 60 cents per kWh on a net feed-in basis, for systems of up to a 5 kW capacity. This scheme was closed to new applicants at the end of 2011 and was replaced by two schemes: the Standard Feed-in Tariff scheme and the Transitional Feed-in Tariff scheme. The former scheme applied to systems of up to 100 kW in capacity and offered a one-for-one rate matching the current retail price of electricity. The transitional scheme offered a minimum of 25 cents per kWh net FiT and applied only to schemes of up to 5 kW in capacity. The Standard Feed-in Tariff and Transitional Feed-in Tariff schemes were closed to new applicants on 31 December 2012.

67 The current Victorian FiT scheme commenced on 1 January 2013 and applies to eligible renewable energy systems of less than a 100 kW capacity. It provides for a minimum net FiT as determined by the Victorian Essential Services Commission (ESC). This minimum FiT was set at 8 cents per kWh for 2013 and 2014. For 2015, the minimum FiT is 6.2 cents per kWh. From 1 January 2016, the minimum rate of 5 cents per kWh was applied to new applicants.

68 The Queensland government commenced a Solar Bonus Scheme in 2008 that paid 44 cents per kWh on a net FiT to customers with a roof-top solar PV system of less than a 5 kW capacity. This scheme was closed to new applicants on 9 July 2012 and different FiT rates are now available from different electricity retailers in South East Queensland. For regional Queensland, a minimum FiT is mandated and has been set at 6.3 cents per kWh from 1 July 2015.

69 South Australia commenced a net FiT scheme in July 2008 that paid 44 cents per kWh and was open to customers consuming less than 160 mWh per annum. A reduced net FiT of 16 cents per kWh was introduced on 30 September 2011. Commencing from 1 January 2013, the FiT is determined by the Essential Services Commission of South Australia and was set at 6 cents per kWh until 31 December 2014, at which point the rate fell to 5.3 cents per kWh. In 2016 the minimum retailer payment was 6.8 cents per kWh.

70 Western Australia started a FiT scheme on 1 July 2010 under the renewable energy buy-back scheme. Under this net FiT arrangement the state government contributed 40 cents per kWh and a further 7 cents per kWh was paid by the customer's electricity retailer. This scheme was closed to new applicants on 1 August 2011. The FiT is now determined by the Western Australian electricity retailers who offer a different FiT for different customers based primarily on their location.

71 Tasmania operates a net FiT scheme which commenced with a FiT of 27.8 cents per kWh. This scheme was closed to new applicants on 1 September 2013. For renewable energy systems installed between 1 September and 31 December 2013 a transitional FiT of 8.3 cents per kWh applied. From 1 January 2014, the FiT is determined by the Tasmanian Energy Regulator and was set at 5.56 cents per kWh for the period 1 July 2014 to 30 June 2015. This minimum rate was revised to 5.5 cents per kWh for the period 1 July 2015 to 20 June 2016.

72 The Northern Territory operates a gross FiT arrangement. This means that the electricity generated by a solar installation system is sold back to the electricity retailer for the same price the household or business purchase it for. It also means that all of the electricity generated by the solar installation is purchased by the electricity retailer; this includes the electricity generated and then used by the household/business and the excess electricity fed back into the grid. The FiT has been relatively stable within the Northern Territory for the time series contained in this publication.

73 The ACT maintains a gross FiT scheme. The scheme commenced on 1 March 2009 and initially offered a FiT of 50 cents per kWh for systems with a capacity of up to 10 kW and 40 cents per kWh for systems larger than 10 kW up to 30 kWs. For systems installed between 1 July 2010 and 31 May 2011 and with a capacity of up to 30 kW the applicable FiT is 45.7 cents per kWh. As of 14 July 2011 the ACT ceased to regulate FiT rates for roof-top solar PV systems and rates are determined by the electricity retailers operating in the territory. In 2016, the FiT offered by electricity retailers in the ACT varies between 6 cents and 7.5 cents per kWh.

74 Local government policies also have the potential to influence employment in renewable energy activities. For example, both Hobart City Council and Brisbane City Council have offered rebates on the installation of new solar hot water systems. The ACT Energy Wise Program offered rebates to homeowners and tenants undertaking energy saving improvements to their residence, including the installation of solar hot water systems. Some councils have offered interest-free finance to install roof-top solar PV systems, for example, Darebin City Council offered such a scheme to eligible pensioners.

75 The net effect of the interaction of federal, state/territory and local government policies on renewable energy and related employment thus varies by location and over time.

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Glossary

GLOSSARY

Accredited solar PV installer

The Clean Energy Council holds the authority to grant accreditation to installers of solar PV

systems. A solar PV system installed by an accredited installer becomes eligible for feed in tariff and Small-scale Technology Certificates.

ANZSIC

The **Australian and New Zealand Standard Industrial Classification** (ANZSIC) is the standard classification used in Australia and New Zealand for the collection, compilation, and publication of industry statistics.

Bagasse

Bagasse is the fibrous stalk of sugar cane which remains as residue from the sugar cane milling process. It is typically used as a fuel to produce electricity for the milling and refining of sugar cane.

Bio diesel

Bio diesel is an oil produced from renewable organic sources containing fatty acids using a process of condensation called transesterification.

Bio ethanol

Bio ethanol is ethanol produced from renewable organic sources, typically from agricultural feedstocks such as sugar cane.

Biofuels

Biofuels are fuels produced from renewable organic sources. Biofuels include bioethanol and biodiesel which are commonly used as transportation fuels, and landfill gas which is commonly used in the generation of electricity.

Black liquor

A liquid residue formed during the pulping of wood to make paper, having a high concentration of lignin and capable of being used as a biomass fuel.

Conversion loss

The generation of energy typically involves its conversion from one form (e.g. coal) into a preferred form (e.g. electricity). In such a conversion part of the original energy is lost, for example, through dissipation in the form of heat, and this is termed a conversion loss.

Direct employment - renewable energy

Direct employment in renewable energy activities is employment directly related to the production of renewable energy, and/or by the design, construction and/or maintenance of renewable energy infrastructure. See also “Indirect employment - renewable energy”.

Electricity

Electricity is the flow of electrical power or charge. Electricity is commonly derived from burning organic matter, especially coal and natural gas. Other sources include hydro, wind and biomass.

Employment factor

An employment factor describes the number of FTE employees required to manufacture, assemble and install one unit of renewable energy generation capacity. See also “Employment factor approach”.

Employment factor approach

The employment factor approach is a method used to estimate FTE employment in renewable energy activities. It combines an employment factor with a measure of renewable energy generation capacity. See also “Employment factor”.

Environmental accounts

Environmental accounts are accounts produced using the principles of the SEEA. These accounts are produced in a systematic manner, using underlying principles that allow their integration with information produced in accordance with the System of National Accounts. See also “System of Environmental-Economic Accounting”.

Full time equivalent (FTE)

Full time equivalent (FTE) employment is a unit of employee workload whereby employee numbers are expressed in terms of the hours of a typical full-time employee. Thus, the FTE of a full-time staff member is equal to 1.0. The calculation of FTE for part-time staff is based on the proportion of time worked compared to that worked by full-time staff performing similar duties. The use of FTE enables comparisons of employee workloads across various contexts.

Geothermal power

Geothermal power is generated by using the thermal energy naturally generated and stored in the Earth.

Hydropower

Hydropower (hydro) is a process in which flowing water is harnessed to generate power, usually as electricity.

Indirect employment - renewable energy

Indirect employment in renewable energy activities comprises all employment related to the production of intermediate inputs related to installing, operating and maintaining renewable energy infrastructure. See also “Direct employment - renewable energy”.

Kilowatt (kW)

A Kilowatt (kW) is a measure of electric power, equal to one thousand watts.

Kraft milling process

The kraft process (also known as kraft pumping or sulfate process) is the process of conversion of wood into wood pulp, which consist of almost pure cellulose fibres, the main component of paper.

Landfill gas

Landfill gas results from the breakdown of putrescible materials in waste deposited at landfill sites. This gas may be used to drive turbines to generate electricity.

Megawatt (MW)

A Megawatt is a measure of electric power, equal to one million watts.

National Accounts

The national accounts are a systematic summary of national economic activity produced in accordance with the recommendations of the System of National Accounts (SNA). At a detailed level they show a statistical picture of the performance and structure of the economy. For further information please refer to the Australian System of National Accounts: Concepts, sources and Methods, 2015 (cat. no. 5216.0).

Non-profit institutions

Non-profit institutions (NPIs) are organisations that are not-for-profit and non-profit-distributing; they are institutionally separate from government and are self-governing.

Petajoule

A petajoule is a measure of energy, equal to 1,000,000,000,000,000 (10 to the power of 15) joules.

Production boundary

The SNA production boundary is a definition of activities deemed to be 'productive' and therefore to be included in SNA measures of output and production. The production boundary thus determines the size and nature of national accounting aggregates such as Gross Domestic Product (GDP).

Renewable energy activities

Renewable energy activities are those activities principally motivated by the production of renewable energy, and/or by the design, construction and/or operation and maintenance of renewable energy infrastructure.

Roof-top solar photovoltaic (PV)

Roof-top solar photovoltaic (PV) is a renewable energy generation system that uses PV modules ('solar panels') sited on a rooftop to convert solar energy into electricity. A solar inverter converts this electricity from direct current (DC) to alternating current (AC) to match the type of electricity coming from the network.

Satellite accounts

Satellite accounts are accounts that provide a framework linked to the core national accounts and which enable attention to be focussed on a particular field or aspect of socio economic life in the context of the national accounts.

Solar energy

Solar energy refers to energy used for electricity generation (by photovoltaic conversion or solar thermal generation) and to energy used to heat water in solar hot water systems.

Solar hot water system (HWS)

A solar HWS uses solar collectors to absorb energy from the sun and heat water.

System of Environmental-Economic Accounting (SEEA)

The central framework of the System of Environmental and Economic Accounting (SEEA) is an international statistical standard for environmental-economic accounts ('environmental accounts'). It is a multipurpose conceptual framework for understanding interactions between the economy and the environment, and for describing stocks and changes in stocks of environmental assets. It is consistent with the SNA.

System of National Accounts (SNA)

The System of National Accounts (SNA) is an international statistical standard for economic accounts. It is a framework that provides a comprehensive, consistent and flexible set of macroeconomic accounts for a range of applications. It is consistent with the SEEA.

Wind power

Wind power refers to the conversion of wind energy into electricity using wind turbines.

Abbreviations

ABBREVIATIONS

ACT	Australian Capital Territory
ABS	Australian Bureau of Statistics
ANZSIC	Australian and New Zealand Standard Industrial Classification
ARENA	Australian Renewable Energy Agency
CEFC	Clean Energy Finance Corporation
ESC	Essential Services Commission
FiT	Feed-in tariff
FTE	Full time equivalent
GDP	Gross Domestic Product
HWS	Hot water system
ICT	Information and Communication Technologies
IPART	Independent Pricing and Regulatory Tribunal
IRENA	International Renewable Energy Agency
kW	kilowatt
kWh	kilowatt hour
LRET	Large-scale Renewable Energy Target
MW	megawatt
NPIs	Non-profit institutions
NSW	New South Wales
NT	Northern Territory
PV	photovoltaic
QLD	Queensland
RECs	Renewable Energy Certificates
RET	Renewable Energy Target
SA	South Australia

SEEA	System of Environmental-Economic Accounting
SNA	System of National Accounts
SRES	Small-scale Renewable Energy Scheme
Tas	Tasmania
Vic	Victoria
WA	Western Australia

International statistical standards and the concept of Employment in Renewable Energy Activities (Appendix)

APPENDIX 1 INTERNATIONAL STATISTICAL STANDARDS AND THE CONCEPT OF EMPLOYMENT IN RENEWABLE ENERGY ACTIVITIES

The development of experimental statistics, such as the estimates of employment in renewable energy activities contained in this publication, relies heavily on what can be sourced from within the data environment presently available. Nevertheless, it is critically important to have a clear concept of what is to be measured. This section describes the notion and scope of estimates of employment in renewable energy activities used in this publication.

International standards and guidelines exist to guide our understanding and definition of various aspects of the economy including production, consumption and employment. However, there is little in the way of international guidance on what precisely is meant by employment in renewable energy activities.

The 2008 edition of the **System of National Accounts** (SNA) defines employees as

> "persons who, by agreement, work for a resident institutional unit and receive remuneration for their labour." (SNA, paragraph 19.20).

SNA (paragraph 19.19) defines employment as

> "all persons, both employees and self-employed persons, engaged in some productive activity that falls within the production boundary of the SNA and that is undertaken by a resident institutional unit".

SNA (paragraph 1.7) describes the range of economic activities that institutional units may engage in, namely, production, consumption and the accumulation of assets.

Employment in renewable energy activities thus relates to both employees and self-employed persons engaged in productive activities falling within the production boundary of the SNA. (From this position, the definition of 'renewable energy activities' becomes crucial and this is described in detail within the Explanatory Notes of this publication.)

The guiding principle of industry classification is the grouping together of all establishments engaged in the same, or similar, kinds of activity (SNA 2008, paragraph 5.2). Productive activities are carried out by institutional units and each institutional unit is allocated to an industry on the basis of its predominant activity. All employees of this institutional unit are in consequence allocated to this same industry. Thus, in official ABS Labour Market statistics, industry estimates of employment involve assigning employees to the industry of their employer. The 2006 edition of the Australian and New Zealand Standard Industrial Classification (ANZSIC), 2006 (cat. no. 1292.0) provides the basis for these industry estimates.

Standard industry classifications are designed to capture and separately identify a wide range of types of economic activity. For example, units predominantly engaged in aluminium smelting typically do not undertake significant secondary activity. Nor is aluminium smelting typically carried out by other industries as a secondary activity. Thus, in practice, employment assigned to the industry 'ANZSIC Class 2132 Aluminium Smelting' should equate closely to numbers of employees who undertake the activity of aluminium smelting. The same is not generally true of renewable energy activities. Some employment in renewable energy activities relates to the secondary activity of an employer whose predominant activity is not a renewable energy activity. In particular, much of this employment relates to the installation of renewable energy infrastructure by units that are predominantly engaged in construction or other activities.

To a limited degree ANZSIC 2006 supports the direct capture of employment in renewable energy activities. Hydropower is classified in ANZSIC as "2612 Hydro-Electricity Generation" and ANZSIC "2619 Other Electricity Generation" will also capture, in total, much of the remaining activity related to electricity produced from renewable sources.

Quality Declaration - Summary

QUALITY DECLARATION - SUMMARY

INSTITUTIONAL ENVIRONMENT

For information on the institutional environment of the Australian Bureau of Statistics (ABS), including the legislative obligations of the ABS, financing and governance arrangements, and mechanisms for scrutiny of ABS operations, please see ABS Institutional Environment.

In producing the experimental estimates contained in this publication the ABS has used three broad approaches. These approaches are as follows:

1. Accessing publicly available information such as company annual reports, information provided on company websites, industry association reports and data drawn from the Renewable Energy Certificate (REC) Registry maintained by the Clean Energy Regulator.

2. Making use of the employment factor approach. This approach is a modelling technique that utilises information on installed capacities of renewable energy infrastructure, numbers of installations and employment factors. Employment factors indicate the number of annual direct Full Time Equivalent (FTE) jobs created per physical unit of choice, for example, numbers of annual FTE employees created per megawatt (MW) of installed capacity of wind power. It is an estimation technique that has been widely used internationally to estimate employment numbers associated with renewable energy activities.

3. Using employment numbers provided directly by the institutional unit.

RELEVANCE

Employment in Renewable Energy Activities, Australia (cat. no. 4631.0) presents estimates of annual direct full time equivalent (FTE) employment in renewable energy activities, by state and territory and by type of renewable energy. These estimates are the third set of official Australian estimates of FTE employment in renewable energy activities and will allow

analysts to better understand employment patterns in Australia. They update and replace the previous sets of estimates of employment in renewable energy activities, released in April 2015 and March 2016.

TIMELINESS

Estimates of annual direct full time equivalent (FTE) employment in renewable energy activities contained within **Employment in Renewable Energy Activities, Australia** are released within 9 months of the end of the reference period.

ACCURACY

Data published in **Employment in Renewable Energy Activities, Australia** are considered analytically useful but are also considered experimental and data quality is expected to improve in subsequent editions of this publication.

COHERENCE

This publication contains experimental ABS estimates of employment in renewable energy activity. The definitions of employees and employment used in this publication follow the System of National Accounts and are consistent with those used throughout ABS employment statistics.

INTERPRETABILITY

The explanatory notes of this publication contain four sections, which cover:

- Scope of renewable energy activities
- Categories of renewable energy activities
- Direct and indirect employment in renewable energy activities
- Estimation methodology.

ACCESSIBILITY

The data contained in this publication comprise the full detail of publishable data for **Employment in Renewable Energy Activities, Australia** and as such it is not possible to provide any further information beyond that presented in the publication. Tables contained in this publication are available in spreadsheet format in the downloads tab. For more detail on the publication please contact the National Information and Referral Service on 1300 135 070.